Analysis of Mixing and Dynamics Associated with the Dissolution of Hurricane-Induced Cold Wakes

Carol Anne Clayson
Dept. of Physical Oceanography
Woods Hole Oceanographic Institution
Woods Hole, MA
phone: (508) 289-3626 fax: (508) 457-2181 email: cclayson@whoi.edu

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LONG-TERM GOALS

The main objective of the research is to provide scientists with a clearer understanding of the relative importance of the physical mechanisms involved in the recovery of the ocean from a cold wake formation, and to provide additional value and insight to the observations already being undertaken by the ITOP program.

OBJECTIVES

Our approach is to take two three-dimensional ocean models (our version of CUPOM and HYCOM) that have been adapted for idealized simulations and conduct a series of experiments aimed at understanding the relative roles of the surface forcing, wave-induced mixing and other turbulent processes, and horizontal eddy actions at the mesoscale and submesoscale regimes in affecting the recovery of the ocean from the tropical cyclone. The comparisons of the two models will also provide information on the uncertainty of our results due to varying physical parameterizations of the models, and also provide insight into our further realistic model simulations with the POM model as compared to the work that other researchers are performing with HYCOM.

APPROACH

The approach is to use two high-resolution ocean models (a hybrid version of CUPOM, and HYCOM), and use idealized and realistic simulations of cold wakes and observations from the ITOP field campaign to investigate the restratification processes affecting cold wakes.

WORK COMPLETED

Our project started in partway through this fiscal year. Since the project is now based at WHOI, we needed to make part-time use of a research associate here at WHOI. This person has been identified (Sachiko Yoshida), but she has been able to spend much time spinning up on this project as her previous project is still winding down.

However, we have already made progress in porting over the CUPOM version of the code to WHOI, and have been able to make some initial sensitivity simulations (see Figure 1). We are currently

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working on obtaining observations and modeling results from other ITOP investigators for use in forcing/analyzing the model simulations. In consultation with L. St. Laurent and S. Jayne, we have decided that we can add value to the turbulence measurements by focusing on the following key science questions in our models:

(1) What is the relative importance of key mixing mechanisms that are evident in enhanced levels of dissipation near the surface relative to deeper measurements (momentum/wave forcing, inertial oscillations, and heat loss)?

(2) Observations during ITOP clearly demonstrated the importance of multiple features driving restratification of the cold wake, and we will attempt to investigate the importance of the surface heat flux, submesoscale variability, and mesoscale shear in both idealized cold wake scenarios and those corresponding to the measurements during the ITOP field campaign.

RESULTS

In the following year we anticipate fulfilling our year one goals, as well as making significant progress in the first of our year two goals. These include finishing the gathering of all modeling and observations for forcing realistic model simulations of the ITOP field campaigns; the porting over of the CUPOM and the HYCOM to WHOI, with additional work on porting the CUPOM to the cluster for 1 km model simulations; and work on idealized model simulations.

IMPACT/APPLICATIONS

ONR has a substantial investment in ITOP, and in the ITOP Cold wake cruises, to provide high-quality turbulence and other upper ocean measurements related to the development and recovery of the cold wakes. This work will greatly enhance the physical understanding that will come from that investment. It is anticipated that this understanding can directly benefit researchers using coupled atmosphere-ocean models to predict hurricane track and intensity, and can also be used to address the importance of hurricane-induced mixing for the global ocean thermohaline circulation and the global climate.

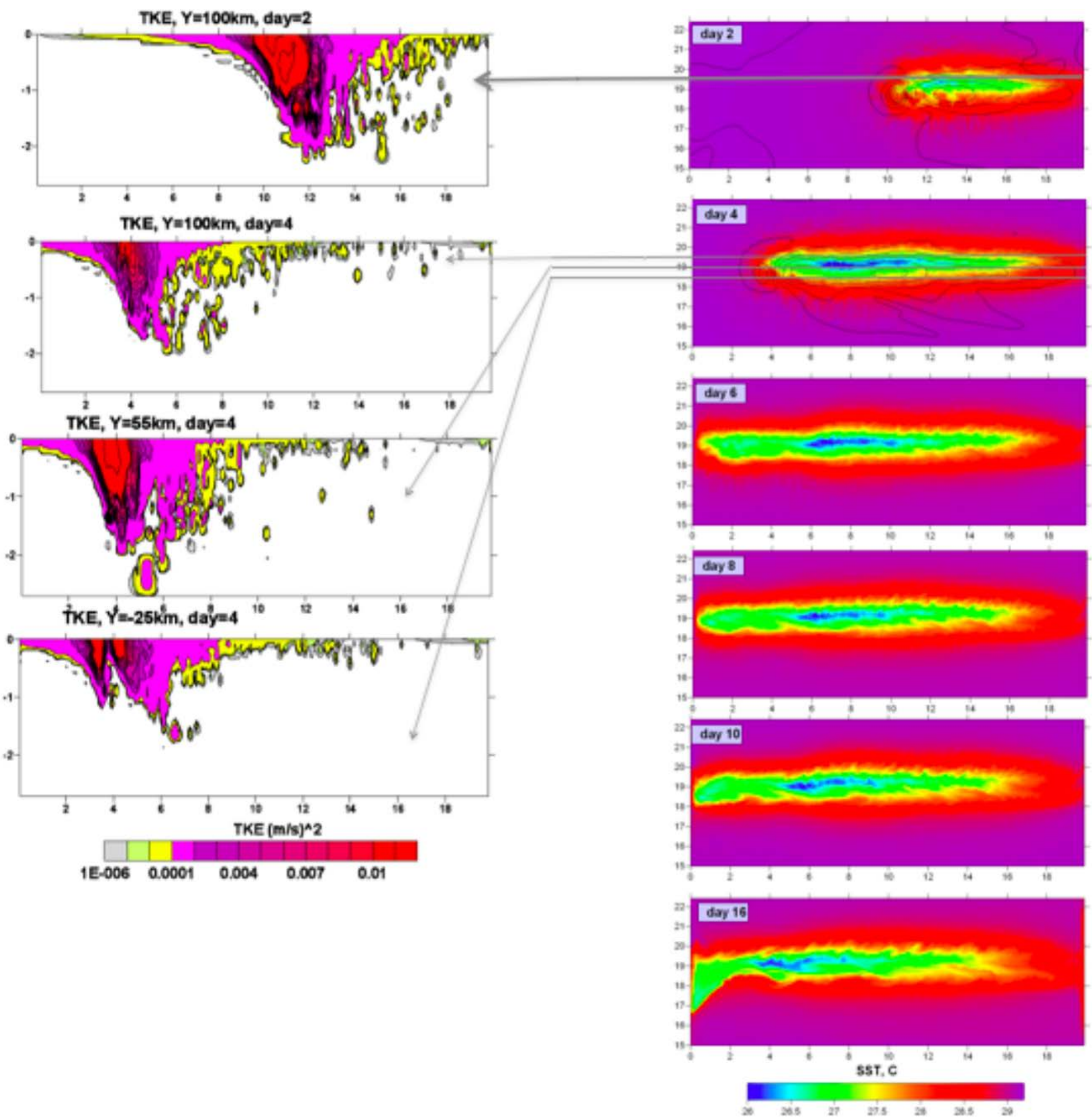

Figure 1. Model simulations of the sea surface temperature (right) and turbulence kinetic energy (left). Days noted are number of days after the hurricane enters the box at the eastern edge (taking roughly 5 days to pass through the box). The hurricane passes through the box at Y = 0 km (roughly 18.5^o), with the largest cooling taking place to the right of the eye.